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"Internet of things and product innovation"

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Abstract (Italian)

In questo elaborato, dopo aver definito cosa sia l'internet delle cose e cosa comporti, ne vengono analizzati gli elementi che influenzano l'innovazione di prodotto. In particolare, vengono esplorati i campi di applicazione per le tecnologie basate sull'internet delle cose e gli aspetti che le aziende dovrebbero considerare con più attenzione per supportare al meglio le decisioni strategiche riguardo lo sviluppo di nuovi prodotti.

Introduction

In today's fast-paced world, companies must try to preserve their position in the market by understanding which are the technologies threatening to escalate into disruptive changes, in order to be first movers or adapt to it.

In this dissertation one of these technologies, the internet of things, will be analysed together with its impact on product innovation, to comprehend which are the most relevant factors firms need to address in order to succeed.

In the first chapter an overview of what the internet of things is and how it evolved is given, providing an example of a type of sensor and why it could be helpful for companies. Then, possible applications are explored, mentioning a variety of industries where the integration of this technology would be positive, providing practical examples. At the end of the chapter, implications are discussed, both positive and negative, in order to have a wider general view of the consequences of this technology.

The IoT plays a fundamental role in product innovation, bringing forth many new strategic tools and challenges. These are analysed in chapter two, which begins with an explanation of what innovation is and a clarification of methods to evaluate it. The section continues with a summary of which steps make up the innovation process and how the internet of things might support them. Then, the influence the internet of things has on product innovation is discussed, mentioning a useful tool born together with this new technology. Lastly, factors influencing product development are discussed, along with challenges and opportunities companies must acknowledge.

The third and last chapter focuses on the wearable technology industry, explaining why integration of the internet of things in this context poses peculiar challenges and giving several examples of Italian companies succeeding, along with a brief analysis of factors influencing their product development process.

Chapter 1: The internet of things

1.1 The evolution of the internet of things

Since its debut to the big public in the 1990s, the internet has contributed to shaping the way we interact with technology. What before 1995 was simply a network meant for communication inside scientific communities and governments, quickly became the main mass communication media, home to countless businesses and endless knowledge.

The new frontier of the relationship between man and a connected network is the internet of things, which is changing many aspects of the world we live in, from the way we drive, to how we make purchases, and even how we get energy for our homes.

Connected devices are now becoming our essential companions, helping with many different tasks ranging from the most complex like having surgery remotely, to the simplest, like keeping track of appointments. We are now able to talk with our homes and tell them when to warm up or turn the lights on.

Even though it's very difficult to pinpoint a precise moment in history when the revolution of the internet of things began, the process can be divided into phases.
The first one, which can be defined as pre-IoT, is represented by simple sensors, capable of collecting data in a precise manner. These sensors are programmed to detect specific, pre-determined information, which is then stored without the support of a network, and later collected manually. A straightforward example of this stage is the previous generation of pollution detection towers, very common in the first years of the new millennium, placed in strategic locations inside cities to record the level of polluting particles in the air. These units simply kept the information in a memory chip, which was periodically checked on the spot by authorized personnel.
The next phase is marked by the introduction of a network connection, where the sensor can upload the data collected. In order to do this, objects must be also equipped with antennas for connectivity, like Bluetooth or wi-fi motherboards. This is the reason why the revolution of the internet of things could not have happened before it did: the degree of technological progress had to be advanced enough to allow objects as small as bracelets and earphones to contain processors, sensors, antennas, data storage, and everything else the user might need. These devices, now linked together or connected to a central server, can process data in order to make a primary selection based on prearranged rules. This can prove useful to analyse information and communicate in a practical and schematic way for immediate comprehension, to transfer only data corresponding to specific requirements in order to limit the amount of unnecessary

waste in digital storage or network transmissions, or to perform actions based on the data collected, which ultimately leads to automation. (Bellini, IoT (Internet of Things): significato, esempi e applicazioni pratiche, 2019)

It's easy to assert that a turning point in this revolution was the launch of Apple's iPhone in 2007, which provided people with a powerful hand-sized device. Apple created its own technological ecosystem made of several devices (computers, cell phones, mp3 players, etc), all connected to the same cloud for easy data sharing and compatibility. The iPhone's lunch brought people, who previously knew the brand for computers, to be more aware of all the other products offered by the firm. Apple's success pressured companies to start developing products in a similar manner, thinking not only of the product itself, but of the entire ecosystem surrounding it. (Greengard, 2017)

1.2 What is the IoT?

The internet of things (IoT) is a scalable network of connected objects, ranging from industrial machines to final consumer goods, and involving several technologies. These devices can gather and share data about how, when and where they are used and how they work together. All this is possible thanks to sophisticated sensors and chips imbedded in every physical device, each transmitting valuable data with the help of processors, digital storage and network connections.

The internet of things provides a platform for all these devices and apps to safely share the information collected and a common language for them to communicate with each other. Thanks to the integrated management and aggregation of this large quantity of data, the platform can apply analytics to share with applications addressing industry specific needs the most valuable information, which can be used to enrich and improve user experience, automation and efficiency.
All this is a premise to one of the greatest advantages of the Internet of Things, the never-achieved-before high degree of customization. Thanks to the constant monitoring, methods of use, customer preferences and customer satisfaction become key variables for product customization, which consequently becomes a great strategic advantage and an attractive opportunity for companies looking for new ways to establish their presence in the market and in people's awareness. (HT, 2018)

According to Brandon-Jones, Slack and Johnson (2016) the internet of things has the potential to reduce costs and risks, improve processes and create new business opportunities.

Transforming products into smart devices enables information networks to create an incredible amount of data by perceiving the external environment and the objects in the network. This large volume of information is extremely precious for companies and it is the foundation of an entire new market, as it will be discussed later on.

Once, IoT was composed of a collection of disparate networks built for specific purposes. As IoT evolved, these networks were linked together and connected, adding security, analytics, and management capabilities. What once was only a streamline flow of information coming from a single device is now becoming an intertwined agglomerate of useful data automatically combined and analysed by algorithms and made accessible from any place in the world. The merging of networks gives rise also to new and valuable opportunities for compatibility and interoperability. (Evans, 2011)

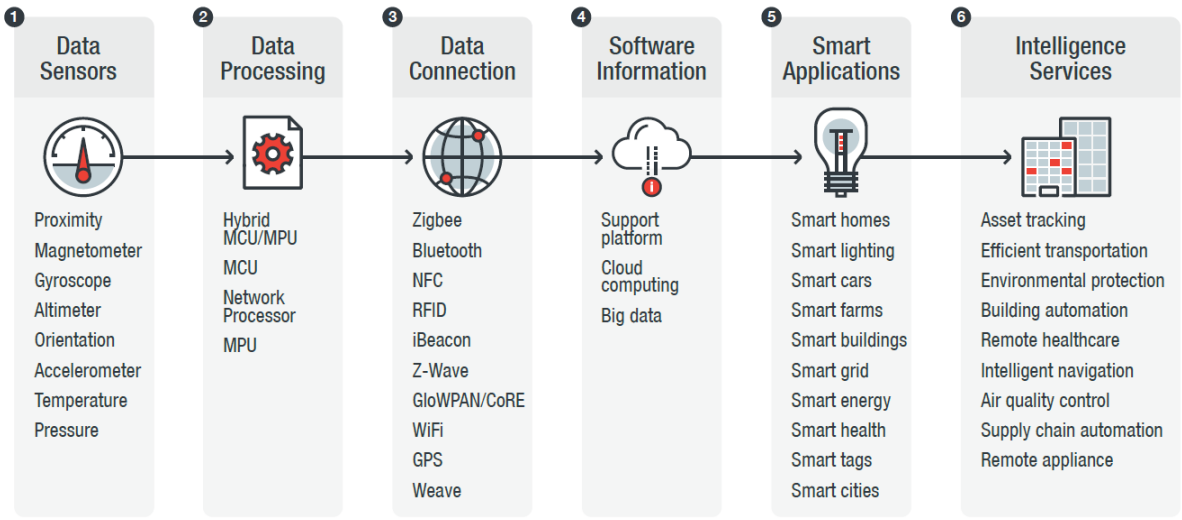

Figure 1 - Elements in the IoT system, source: trendmicro.com

1.2.1 An example of IoT enabling technology: RFID sensors

The Universal Product Code (known to most people as bar code) was developed in 1973, enabling a product or a component to be quickly identified when read by a bar-code scanner. Commonly used during checkout in almost any store or supermarket worldwide, they also have a vital role in speeding up and optimizing supply chain management, allowing manufacturers to keep track of products passing through processes. However, in today's fast-paced industry, some limitations of the bar-code system arise: in order for a bar code to be read the item has to be well aligned with the reader, bar codes can only be scanned one by one, and, because of the

code's nature, only a category of items can be identified. For example, a bar code could be paired with a specific book, but any identical copy of that book would have an identical code, the system does not allow to distinguish between a copy of that book shipped to Chicago and one shipped to San Diego.

A solution to these drawbacks is the use of automatic identification technologies such as radio frequency identification (RFID). This system implies the use of an identifying code (called electronic product code, ePC) made of 96 digits, or bits, which is embedded in a memory chip inside a smart tag. Each single product is then equipped with its uniquely assigned smart label, allowing every code to identify the commodity with an exclusively assigned radio impulse. (Brandon-Jones, Slack, & Johnston, 2016)

RFID technology can be both "active", meaning it's linked with a power supply, like a battery, or "passive", simply getting the energy needed to function from nearby readers. This last variant is particularly attractive because of many perks. Firstly, not requiring any power supply means the sensors can be much smaller, making it suitable for very small devices, and can be used in situations where the fire hazards of a power supply constitute a restraint. This also allows savings in electricity bills or batteries, which also generate less environmental pollution. Secondly, tags can last for decades without any significant loss in the quality of the signal produced. For most items this means the tag will last for the entire life of the product without needing to be replaced. But, even if economies of scale have emerged with the increased volume required by the diffusion of connected products, the cost of such chips and sensors is still a significant factor in adopting the technology. (Greengard, 2017)

Each label is composed of a transponder, which varies in frequency depending on its purpose, allowing the detecting at various distances during its manufacture, distribution, storage and sale, without the need for direct contact. The reader is equipped with an antenna capable of activating the labels with an electromagnetic impulse generated when it's powered on. The reader can then transmit the item's embedded identifying code to a network, such as the Internet.

However, in order for this procedure to take place smoothly, it is necessary to try to configure the reading management program and the tag reading process with care and precision, in order to prevent any kind of complication. Additionally, both the labels and the reader must be calibrated in such a way that any magnetic radio interference is prevented from negatively affecting the reading and exchange of information between labels and other devices.
These sensors, with their ability to connect all together, allow the merging of physical networks and information networks, forming the internet of things. (Brandon-Jones, Slack, & Johnston,

2016) (Bellini, Tag etichetta RFID: cos'è, come funziona ed esempi dell'identificazione a radiofrequenze, 2018)

1.3 Applications

It's incredibly easy to undervalue the practical consequences of even the simplest technologies throughout history, concentrating only on the most evident effects. The wheel, by providing humans with a new way of transporting people, animals and objects, changed agriculture and the way we thought of distances; the lightbulb changed the way architects design buildings, providing light where before there needed to be a window. Just as these apparently simple technologies brought upon radical and indirect transformations, so the internet, in all its complexity and potential, changed and will change the way technology is implemented in our life. (Greengard, 2017)

Applications for interconnected objects go beyond just home automation and differ vastly from industry to industry. Smart sensors connected to industrial equipment can lead to predictive maintenance solutions and increased efficiency of the workflow. Extremely sophisticated chips in aircraft engines increase exponentially the operational safety by providing constant readings on the status of its components, which in turn allow preventive intervention. (Loka, 2017)

Key application fields, also called IoT verticals in the dedicated literature, for the internet of things will be explored in the following table. (Rayes & Salam, 2018)

Table 1 - Field of application for IoT empowered devices, provided with examples

FIELD	EXAMPLES	ADVANTAGES
Agriculture and farming	Sensors can monitor soil moisture, crop growth, livestock feed levels, and irrigation equipment. Smart connected tags on livestock can pinpoint their location and condition.	These solutions not only allow for increased productivity, but can also lead to savings, like optimal water usage. Tags on animals can alert if one of them is having health issues and prevent cattle from getting lost in the pastures, making livestock management easier and more effective.
Energy	Smart electric meters offer dynamic monitoring of electricity consumption.	Companies are able to get valuable information regarding usage patterns, allowing the creation of tailored energy supply contracts and making the

		management of power plants more efficient.
Smart buildings	Applications can be safety monitoring; emergency services triggering in case of flooding, hazardous gases detection, etc; commodities control like air conditioning, water temperature and heating; home automation like appliances control and smart lighting.	In the private sector, all the features of a smart automated home appeal to the public's desire to save as much time as possible and to own futuristic devices.
		In the public sector, smart monitoring and automatic alerting can greatly improve the safety conditions of people present in a building. It can make the efforts of emergency services more efficient by signalling exactly where the hazard is located and by suggesting the best course of action.
Finance	IoT implementation includes payment processing and usage-based insurances.	Payment processing is made quicker by smart devices and, together with intelligent and integrated tracking of transactions, allows for effective fraud and tax evasion reduction. Data collected on customers can improve the process of tailoring insurance offers.
Healthcare	Fall detection for senior citizens, tracking of medical devices inside hospitals, monitoring of vitals and other levels (e.g. glucose levels in diabetic patients), disease	Tracking medical devices inside hospitals can make their retrieval much quicker, which is fundamental in case of time-sensitive surgeries, and being able to monitor their condition makes maintenance or replacement easier.

	management. A great example is posed by smart pacemakers, able to monitor the heart rhythm, transmit the data collected to an app on the patient's phone and even alert emergency services for prompt assistance.	Smart personal devices allow doctors to follow their patients' conditions remotely, and the large amount of data collected can help form diagnosis.
		Connected medical devices can speed up the time required for emergency services to arrive thanks to prompt alerting. The realization that emergency relief will be alerted immediately can give peace of mind to both patients and their loved ones.
Industrial	The internet of things can be used to create new ecosystems between machines, humans and the internet. It can also monitor the entire supply chain, anticipate equipment failures and help responding faster to critical situations.	Supply chain monitoring can help manufacturers, distribution companies and retailers to pinpoint exactly the position and state of every item in the supply chain, making its management easier and more effective. Machine learning can open endless opportunities in terms of improving operational efficiency.
Retail	Smart tags could monitor single products, checkout could be faster thanks to wireless readers and bills could be charged automatically to customers' accounts as they leave the store (like Amazon's physical stores).	A faster checkout process allows stores to have less checkout counters, saving funds for other projects. In the case of supermarkets, smart tags on products enable companies to monitor the expiry date, automatically putting those items on sale to encourage asset rotation.

A great example of application towards smart cities is posed by the work of SenseABLE City Lab, an MIT department led by the Italian Carlo Ratti, studying how to make metropolises more liveable thanks to data collected from millions of linked sensors in the cities themselves, from

smartphones, to pollution detection units, to CCTV cameras. Ratti and his colleagues are convinced that if this information were made available to citizens, it would lead to more rational individual and collective choices, by increasing people's awareness of the implications of daily activities on the sustainability level of the city they live in. (Roche, Nabian, Kloeckl, & Ratti, 2012)

Figure 2 - Example of smart products for home automation by the company Nest, maker of thermostats, smoke detectors and security cameras

1.4 Implications

1.4.1 Internet coverage

Of course, the first implication that comes to mind when thinking about a future where the number of connected products increases exponentially is the need for a fast and widespread internet connection. Factories and homes can rely on a domestic network connection based on cables, but products meant to be mobile, like cars, do not always have a wi-fi router nearby which they can connect to. This problem presents itself even more in the case of remote areas like central Africa or the Australian outback.

According to Vignan Velivela (2015) over four billion people – two thirds of the world population – do not have access to the internet. This could be caused by undersea cables, which

carry 95-99% of the global internet traffic, lacking in ability to reach rural areas if not supported by a vast amount of cell towers.

Later years have seen many attempts to overcome this difficulty by introducing broadcasting satellites, unfortunately without great results, often due to economic factors and satellites' inherent disadvantage of capacity. However, SpaceX, the spacecraft company of famous Tesla founder Elon Musk, has obtained approval by the U.S. Federal Communications Commission for the deploy of almost 12,000 satellites in earth orbit, with the aim of broadcasting a broadband data network to bring fast coverage even to the most remote places. (Foust, 2019)

1.4.2 New Data Source

Before this era of smart and connected products, firms collected data from external sources (such as surveys and market research) and periodically from operations within the value chain (like production processes, sales, etc). This information could prove useful in providing knowledge on customers preference and costs incurred by the company but lacked in contributing to the understanding of how products behaved once they leaved the factory or the store. Now, through IoT, developers, designers and engineers will have a complete overview of product and process performance throughout the entire life span of a commodity, from when supply-gathering starts to when the product gets thrown away or recycled. Thanks to new sensors and the internet of things, the already available and profitable amount of data is supplemented by information on the location of products and their movements, their use and behaviour, etc. (Porter & Heppelmann, 2015). (HT, 2018)

The rise of connected products is opening new possibilities of monitoring variables not measurable before, like the previously mentioned medical devices to monitor heart conditions. Having access to this information can lead to countless advantages, both for business purposes and for the wellbeing of people. Following the example, doctors making a diagnosis will benefit greatly from having continuous statistics without the need for patients to be hospitalized or to employ medical staff at home.

However, in order for data exchange to happen, a new supporting technology infrastructure needs to be built. Just equipping products with the ability to connect to the internet is not sufficient, companies need to develop network and data managing software to allow products to efficiently transfer data to the central server, where companies can benefit from the information received. This platform will not only allow communication between devices but will also run analytics on all the information collected and stored. According to McKinsey (2015) a small percentage of all data collected is well exploited, leaving a lot of additional value

not captured. A well-built software infrastructure would be able to unlock further potential from this great resource.

This infrastructure will introduce a new way of conceiving products, now capable of reporting on their own condition and remotely receiving commands. That gives users the unprecedented ability to remotely operate them in hazardous or hard-to-reach environments, as it is the case for many high-risk duties like relief efforts teams or mining workers. But what is probably the most revolutionary and precious aspect of this new network connection is the ability to exploit algorithms to improve the overall optimization of processes, allowing efficient work between related products, improved performance, utilization and uptime. This comes from the new-found autonomy of the system, now capable of learning, adapting and operating on its own, with minimal user interference. (Porter & Heppelmann, 2015)

1.4.3 Security concerns

Surely being able to track the location and behaviour of products during the production process and the retail stage is a great advantage for companies, but extending data capture beyond checkout, when they are associated with a particular individual that bought or is using that product, poses a great amount of issues concerning security that must not be ignored. The same technology that could prevent or swiftly solve thefts by locating the stolen goods can also be used to track any citizen. (Brandon-Jones, Slack, & Johnston, 2016)

Given the highly complex nature of IoT systems, the security risks associated with them are many and challenging, making the ecosystems often susceptible to manipulation by external parties. IoT devices can be affected by "attacks targeting diverse communication channels, denial of service, physical threats, eavesdropping, and identity fabrication" among others. (Skarmeta, Hernández-Ramos, & Martinez, 2019)

According to Aditya Gupta (2019) there are several factors causing IoT security vulnerabilities, which consequently product innovators and developers need to pay exceptional attention to:

- Security teams not taking into account the concerns posed by the entire device architecture. Often the interconnection between products, more than the products themselves, is the cause of issue.
- The involvement of many stakeholders giving rise to supply-chain-based security issues.

- Developers lacking awareness of security vulnerabilities or missing a proper action plan to tackle this point. This absence of concern could also lead to the use of unsecure frameworks.
- In order to ensure the deployment of IoT at a broad scale, empowering users to control how their data are disclosed is a crucial aspect for any company hoping to succeed in the market with a new or innovated product involving the internet of things.

One of the solutions suggested by Skarmeta, Hernández-Ramos & Martinez (2019) to advance towards user-centric privacy is the integration of contextual data in order to drive the behaviour of devices to security decisions adaptive to the context in which actions are taken, creating context-aware security solutions. This would imply also the use of trustworthiness assessment mechanisms discarding information coming from less reliable devices, to realise a more trustable IoT ecosystem.

Chapter 2: IoT influence on product innovation

In the present chapter innovation and the influence the internet of things has on it will be analysed.

An instrument with such potential as the internet of things would be wasted if not harnessed to further develop technological progress. Therefore, companies hoping to exploit its full potential need to understand the implications of this new innovative technology along all phases of product development, both to benefit from new business opportunities and revenue streams and to appeal to the public's desire of highly technological and futuristic devices.

2.1 What is innovation?

Innovation is the transformation of an idea or a technology into a product marketed to consumers, who perceive a new value. Through innovation, companies are capable of creating a temporary monopoly connected to the availability of the product. The extra profit generated by the innovation process is then progressively mitigated by the diffusion and imitation of the innovated commodity. Innovators manage to shift competition to a more sophisticated level by making the competitors' offer obsolete, driving companies to keep investing in R&D to maintain the strategic advantage achieved, and other players to find new innovations to gain back the market share they have lost. (Di Maria & Bettiol, 2014)

To better analyse and understand how innovation develops, it's fundamental to make several distinctions between kinds of innovation.

A first distinction can be made between the sources, external or internal, that generate it (Di Maria & Bettiol, 2014):

- Demand pull innovation comes from market needs not satisfied by the present assortment of commodities offered, which open ways for companies to introduce new products and technologies to try and fulfil consumers' desires. This kind of innovation is helped by IoT thanks to the large amount of data collected, which, as previously mentioned, can provide firms with precious information about user's latent wishes and needs, and can pinpoint blue oceans[1] ready to be exploited.
- Technology push innovation, on the other hand, focuses on new technologies driving the innovation process, which can be new knowledge generated by scientific

[1] Blue oceans are new market spaces not fully exploited where competition is minimum. (Johnson, Whittington, & Scholes, 2014)

discoveries, newfound ways to apply existing technologies, etc. This new availability drives companies to develop new or improved products, in order to appeal to the market with an offer of superior perceived value. Scientific and technological knowledge, then, have a fundamental role in granting a strategic advantage to companies that have access to or that control them. The environment in which the company develops plays a major role in this, see for example the Silicon Valley, home to many high-tech businesses.

- Design driven innovation generates new value not from consumers' practical needs or new technological solutions, but rather from the attribution of determined principles to the company's offer thanks to design. People attach meaning to the products they buy, so design driven innovation is generated by firms' desire to appeal to this emotional attachment and sell this interpretation, rather than the product's function. In particular, good design can add value to companies by increasing market share, differentiating products and making them more attractive to customers, strengthening the brand and increasing brand awareness. The internet of things, in this context, drives innovation by being a feature perceived by the customers as an additional value, even in products where functionality is not significantly improved by it. This happens because a connected device is considered trendy and a symbol of status, being originally expensive due to its newness. (Brandon-Jones, Slack, & Johnston, 2016)

The internet of things has also had an increasingly crucial role in helping open innovation to take place. Standard innovation is often conceived as something to keep private in order to protect its intellectual property from free riders in the market, which leads to closed innovation. Open innovation, on the other hand, implies a ceaseless flow of knowledge exchanges between the firm and the environment surrounding it thanks to the involvement of customers, external partners and solution providers in the process of generating new ideas, with the aim of accelerating and improving the company's ability to innovate. This concept is based on the notion that a free flow of ideas greatly improves the effectiveness and speed of the product development process, shifting the competitive advantage from maintaining the secrecy of the knowledge capital to being the first to manufacture high quality products. The internet of things aids open innovation by giving companies access to large volumes of data and sophisticated software and providing a platform for ideas exchanges to take place. (Johnson, Whittington, & Scholes, 2014)

Then, it is important to recognize what is the target of the innovation process that has to be renewed or improved:

- Product innovation – which will be the main focus of this chapter – is the concept of designing and making (through industrialization) a product or a service that is completely new or characterized by significantly improved and extended features in respect to the existing ones, corresponding to a new offer for the consumer. It is a change that generates a new level of performance. (Brandon-Jones, Slack, & Johnston, 2016) (Di Maria & Bettiol, 2014)
- Process innovation includes any new technology or organizational solution which redefines or improves company activities, particularly in the context of production and industrialization. (Di Maria & Bettiol, 2014)

However, this interpretation is less and less relevant thanks to the interdependence of these two kinds of innovation. The continuous update of the product portfolio in response to variety-loving market demand requires flexibility and innovation of business processes in order to keep up with intense product innovation dynamics. At the same time, new information and communication technologies, first and foremost the internet of things, allow, through virtualization, the joined management of product development activities, included subsequent industrialization. Increased competitiveness, then, pushes companies to shorten the product life cycle, aiming towards shorter time to market, which in turn requires efficient internal processes. (Di Maria & Bettiol, 2014)

Another important distinction pertains how innovation happens and what effects it has on a company's competitors and the environment in which it operates (Coscia, 2016) (Di Maria & Bettiol, 2014):

- Radical innovation is the development of a completely new product, which makes the competitors' one obsolete and that could be without precedents for the company, the market or both. Radical innovation is typically disruptive, meaning that the introduction of a new product or technology changes the market, creating a moment of discontinuity.
- Incremental innovation is the enrichment or redesign of an existing product through a moderate technological progress.

Not surprisingly incremental innovation is the preferred type by affirmed companies, thanks to its stable nature and low disruptiveness of existing processes. However, companies often fail to adopt these small but potentially remarkable changes in an effective way.

Henderson and Clark, two researchers, investigated this dilemma and theorized another model for defining innovation. They divided the technological knowledge required to develop new products and services into "knowledge of the components of knowledge" and "knowledge of how the components of knowledge link together" (architectural knowledge). In this model

incremental innovation has a low impact on both component and architectural knowledge, building upon existing notions and technologies. Radical innovation, on the other hand, implies new components and new architecture of the processes. The novelty in this model, however, is the rise of two new types of innovation: modular, which has a high impact on the components themselves but low on the link between them, and architectural, which is diametrically opposite. (Brandon-Jones, Slack, & Johnston, 2016)

Often, in order to innovate a product, it's not necessary to create a completely new commodity, as in the case of radical innovation. Thanks to the internet of things, the impact of incremental innovation is becoming increasingly more relevant, making it sufficient just to integrate the IoT in an already existing product in order to create new value and business opportunities. Examples of that could be smart water bottles, which keep their primary function of holding water, but thanks to a sensor and an antenna can connect to their dedicated smartphone app and keep track of the amount of water drunk during the day.

The focus of innovation, up until this new technological revolution, has always been on the functionality of products, where new generations of devices were conceived with the aim of improving performance, convenience, modularity, etc. In the context of this new technological and always connected revolution, however, aesthetics and complementary services are becoming increasingly more relevant in the innovation process. These new value-increasing elements, together with brand awareness, are key contributors to differentiation. Creativity, then, must be given the same consideration as technological knowledge in order to create the perception of an added value in the public, who will then be encouraged to choose that commodity over competitors. (Di Maria & Bettiol, 2014)

2.2 The innovation process

The innovation process involves a number of steps, which will be listed in the table below, in order to bring the initial idea to a finished product that is successful in the market (Brandon-Jones, Slack, & Johnston, 2016).

Table 2 - Steps in the innovation process, along with examples of the IoT's role in them

PHASE	DESCRIPTION	IoT SUPPORT
Generation of the initial idea	This is the stage where companies collect ideas to develop new product concepts. Inspiration can come both from internal sources, like employees	The internet of things plays a major role in collecting information, providing precious data on customer preferences and

	and experts in the firm, and from external sources, like data collected from customers, competitors, and open communities.	needs and even drafts of product concepts generated by intelligent software. The IoT can also help the development of open innovation, as previously explained.
Selection of the best concepts	Different options are assessed using pre-determined criteria and only those passing the selection can proceed to the next phase. This screening process is called “design funnel”.	Thanks to the IoT, criteria can be chosen from actual data, making this screening particularly effective (because it lowers the uncertainty and error-rate of the process) and efficient (because the best option can be chosen more quickly).
Preliminary design	In this phase the main features of the product are defined in order to have a general idea of how it will appear to the public. The aim of this stage is to determine both the parts that form the product and the way they have to be assembled.	These two stages can be greatly helped by the internet of things with the aid of a digital twin, a tool for running computer simulations to understand the reactions of a product when subjected to different situations and environments, allowing firms to assess if the design presents issues before proceeding to create expensive prototypes. The digital twin will be explained more deeply in paragraph 2.2.1.
Simplifying and improving the product concept	It’s important to run several tests on the preliminary design in order to discover any flaws and to assess if there is room for improvement before its launch in the market.	

Prototyping	Given the high risk associated with the launch of a new product in the market, it's wiser to test that product by creating a physical prototype once the final design has been determined. This prototype can be used both by engineers in the firm to run additional tests, or as a first version of the product to be introduced in the market. Many companies choose to test a small batch of products in limited locations first, in order to understand customers reaction to it while limiting the damage in case of a failure.	Applying sensors (like the RFID sensors, previously mentioned in paragraph 1.2.1) to the limited test-lot allows companies to monitor the functioning of products in real time with aggregated and reliable data, enabling the company to solve any problems that have arisen in the release of the next version. Products connected to the internet directly or with a smartphone as intermediary could be improved remotely with a software update, adding new functions or solving bugs.

In this new and always connected context, the product innovation process needs to be based on connected operations in order to ensure smooth and successful progress. For this to happen, product developers need to create what Greg Cline (2017) calls "the digital thread", a communication framework connecting all elements of the manufacturing and retailing process. Thanks to the digital thread, companies can make sure that the internet of things gets incorporated into products flawlessly, which is fundamental to guarantee the successful communication between devices, especially if connections need to be established between products made by different companies. This implies having an integrated view of all phases of a product's lifecycle during every stage of the innovation process, to ensure that new or improved products will be developed in a pragmatic way, without resulting in a very promising idea that fails once it reaches the market.

2.2.1 The digital twin

One of the concepts derived from the internet of things that is most useful for manufacturing companies is the digital twin. To summarize, the digital twin is a virtual model which is an exact replica of the physical asset made from bits. This tool allows data analysis and status monitoring, in order to prevent and face head on any necessity. But most importantly a digital twin enables product developers to test any new feature or situation without the need of

specially made physical environments. The lessons learnt through the digital simulation can be applied in reality, saving time and resources. This is similar to hurricane simulations, where the strength of a storm can be – approximately – measured based on data collected previously and the computing power of machines, without the need for scientists to go on site. A great example of application can be in the aeronautics and space industry: thanks to the digital twin the wear of an aircraft due to predictable causes can be autonomously monitored by an algorithm, complemented by the continuous reading of the sensors on the product itself, which can also detect any anomaly and proactively notify the manufacturer of any intervention needed.

In short, the digital twin makes the development of more complex and innovative products far easier and more efficient. (Cline, 2017)

2.3 Success factors in IoT product innovation

The digital transformation currently happening has several repercussions on many actors.

Firstly, it affects consumers in the form of small, highly connected devices (for example smart phones, GPS devices) and sophisticated electronics embedded into our means of transport, living spaces, and work places.

For companies, on the other hand, this change is a lot more impactful. An analysis carried out by Aberdeen Group found that 27% of manufacturers already plan to reach this digital transformation, especially given the rising demand for high quality and high-performance products, which pressures companies to improve innovation and technology development. Additionally, demand for highly customized products is increasing too, which invites firms to be first movers and exploit the advantages of digitalization. This push towards IoT-integrating products implies a greater effort on functionality, reliability and performance, without compromising other positive and effective features. (Cline, 2017)

Businesses trying to understand what the implications of this new revolution are, must acknowledge some fundamental aspects in order to succeed in the era of IoT.

The first of these is that as products become smart and connected, software has become a strategic differentiator and the primary factor which allows products to operate efficiently and effectively. Consequently, any product created to be connected to the internet of things must have a well-curated and supported software in order to be accepted and appreciated by the market. This leads to a substantial transformation of companies, especially those that were exclusively hardware-based like traditional manufacturers, which are now pressured to develop specific capabilities in software innovation.

Another factor companies need to consider in the context of this new technological revolution regards how people are getting used to products being connected no matter their purpose or category. This could constitute an advantage for innovative IoT companies looking to introduce their product in the market, lowering the learning curve needed to gain full mastery of the device, but could also mean that older and not connected products become obsolete, making IoT integration a forced choice.

2.3.1 The importance of data

Aside from the mere technical innovation of introducing a network connection into products, which, as already mentioned, brings people to purchase those products for the thrill of owning a highly innovative device, another great influence the internet of things is having on the market is linked to it being able to provide companies with precious information about consumers and their behaviour.

The importance of this kind of data was already discussed in paragraph 1.4.2 "New Data Source" but it is worth saying that a connected world allows the understanding of people's needs and desires, even those they themselves are not completely aware of. Some of the people at the top of wealth rankings largely built their fortunes on the insights provided by this kind of knowledge. Most social networks, like Mark Zuckerberg's Facebook, for example, became highly profitable businesses on this basis, providing a "free service" in exchange for demographic information and monitoring on the behaviour of users using their platform (all collected with the help of internet cookies), which in turn can expose which products are wanted or needed, and even to which people they should be targeted. In a market where price is not the leading driver anymore, substituted by the usefulness or desirability of a certain product, these often-unexpressed desires and needs are what innovators must focus on in order to appeal to the public. Knowledge derived from Big Data, being much more reliable than market research, allows companies to innovate and improve products and services with reduced risk of failure in the market or without having to go through an extensive trial-and-error process during development.

2.3.2 Developing an ecosystem

In the light of this newfound technological awareness of the market, companies no longer need to build standalone products, they must start considering the whole product ecosystem, whether that is composed of similar products (e.g. A set of security cameras), or of complementary goods (e.g. An automatic inventory checker which needs to communicate with factory machines). This could imply both simply building an application to enhance the customer

experience of the lead product and making sure all the devices included in the company's offer are well integrated with one another.

Ecosystems could also be made of products from different companies, making complementarity a fundamental concern, especially now that the increased connection between goods makes this step more complex. This new connected landscape has made any product a chance to deliver new and innovative additional services built around the commodity produced, matching and supporting it. This opportunity, however, gives rise to the need of extensive software knowledge, as previously discussed.

A fundamental choice companies have to make, then, is whether to build an entire new ecosystem from the ground, hoping it will reach a critical mass in order for it to spread in the market, or to develop products compatible with already existing systems, exploiting the dominant technology. There are several factors which should be considered when choosing the best option for a given company. Firstly, the current position of the company needs to be assessed, in order to understand leverages and benefits it might have. An already established company, even if in another industry, already has an advantage in creating its own ecosystem because it is known and has a significant knowledge capital and equity availability. Secondly, building a new ecosystem requires an aggressive strategy to prevent a blockade. The new offer, then, needs to be perceived as of equal or superior value compared to competitors, especially in the first stages of the market entry; this will bring the new system to reach the critical mass necessary to grant its propagation.

2.3.4 Challenges and opportunities

According to Loka, 2017, the proliferation of smart and connected devices poses unique challenges and opportunities, some of which were already previously mentioned:

Challenges:

- Interoperability between systems and networks, both from the same and from different companies
- Handling the huge amount of data collected by the devices connected to the network and created by the analysis of the data itself
- Keeping up with technology standards, in continuous evolution following Moore's Law[2]

[2] Based on empirical observations made by Gordon Moore, co-founder of Intel, this law states that processor's performances double every 18 months. This law is strictly connected to technological progress thanks to processors being imbedded in every device.

- Adaptation of software to consumers' needs, granting privacy protection and allowing support on multiple devices
- Conceiving and designing entire ecosystems equipped with dedicated software instead of standalone products

Opportunities:

- Mass adoption thanks to the diffusion of smartphones and the public's appreciation of devices connected to the internet
- Mass personalization allowed by the very nature of software and connection, which opens opportunities for hyper-customization
- Potential to explore and be a part of different business models and industries
- Enhanced utilization
- Direct connection with end-users, meaning concerns can reach the company more easily, leading to increased efficiency in tackling issues
- Decision support systems based on data collected leading to the rise of new business models, which in turn represent new opportunities for revenue streams
- The rise of new services thanks to software and connected products can lead to new opportunities for monetization

Given these important implications regarding the "new era of things", it is more imperative than ever for businesses to focus on more than just functionality and physical features of their products while designing them. The integration of the entire ecosystem needs to be assessed, as well as the security of all data collected, both for corporate espionage reasons and for the privacy of the final consumers. This area will prove extremely difficult to excel in without building strategic partnerships between other knowledge intensive companies, which can provide a great support in developing connected and innovative commodities. (Loka, 2017)

Chapter 3: Wearable technologies in Italy

3.1 Introduction

Between all industries where the IoT can get incorporated into products, the one posing the most challenges is probably the industry of wearable technologies. Items having an electrical component (like home appliances) are the easiest and the most intuitive to integrate with IoT technologies, since additional sensors and antennas can be added among the existing circuits without having major changes in the product itself. Goods made to be worn, however, often present a much higher component of handicraft and artisanship, besides being typically smaller in size, thus being more challenging to innovate with elements that require electrical – and bulky - parts. Clothes, for example, can be innovated in many ways through new revolutionary materials – like new ultra-light polymers – or production processes – like 3D printing – but are difficult to integrate with IoT.

Nevertheless, according to the International Data Corporation (2019), the worldwide market for wearable devices grew 31.4% during just the last quarter of 2018, while in 2016 – just three years ago – the growth of the industry didn't reach 4%.

Part of this success can be attributed to increased ease of use and the rising worldwide trend of fitness, which makes companies able to target specific demographics with products that were previously overlooked for everyday use. This is the path chosen by Apple, for example, with the Apple Watch, now targeted mostly to runners and swimmers, thanks also to the partnership with Nike. (Scarano, 2016)

According to Kritika Mamtani (2017), among features that will have the most impact on wearable devices adoption in 2022 there are the entry of large players, lured into the market by the remarkable profit prospects; the improvement of all technological elements that make the product, like software, processors, sensors, antennas, etc; and the increased awareness of consumers regarding health and fitness. The cost of producing these devices, on the other hand, will lower both in value and in relevance, thanks to economies of experience, increased diffusion of the competences required and technological advancements.

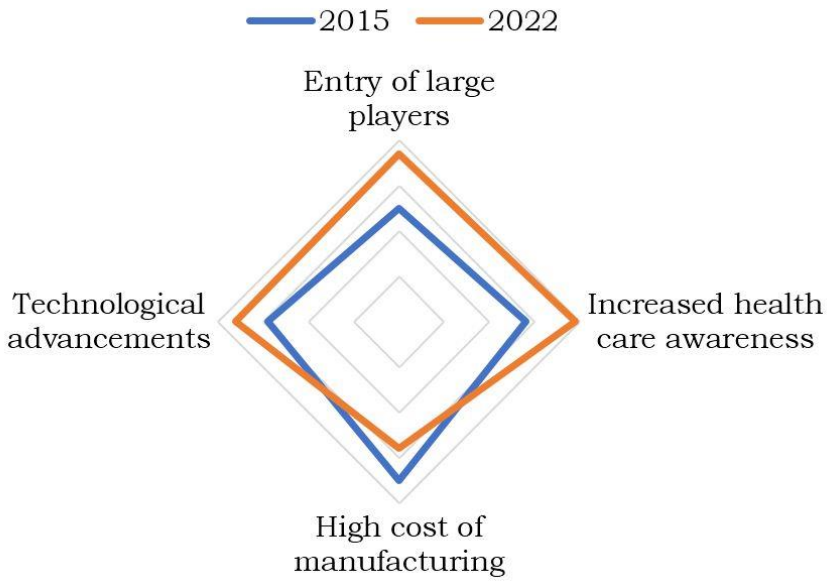

Figure 3 - Factors affecting the wearable technology market, source: Mamtani, 2017

Since the most common wearable technologies are bracelets, watches and all iterations that go on the wrist, among reasons for the unprofitable outcome of this industry during previous years there were disappointed hopes of consumers, probably thinking wearable technologies would have the almost endless features of smartphones, and then embittered by the real functioning of the devices, which were limited by technology, cost or size constraints. (Caprodossi, 2017)

This chapter will now continue with a brief presentation of four Italian companies, makers of remarkable wearable devices. In the following table there is an overview of their business and their lead products, while in the last paragraph, a summary of their most relevant features is offered.

Table 3 - Overview of some remarkable Italian companies in the wearable technologies market

COMPANY	FOUNDATION YEAR	INDUSTRY	PRODUCT
ComfTech	2010	Medical	Tech textile
Empatica	2011	Medical	Smartwatch
Wearable Italia	2016	Jewellery	Bracelets
GlassUp	2017	Cross, mainly industrial	VR visor

3.2 ComfTech

Wearable technologies are not exclusively targeted towards human adults, in fact, it is becoming increasingly common to see the rise of companies addressing pets and infants.

This last category was the original target of Comfortable Technology, a company from Monza, in northern Italy, which started making onesies and overalls in hypoallergenic cotton equipped with a system for the transmission of data on breathing patterns, heartbeat and movements of new-borns. The goal of the project was to allow parents and medical staff to have an early diagnosis of childhood diseases while ensuring the maximum level of comfort for the new-born, granted by the absence of wires. This original product, already patented and certified as a medical device thanks to clinical trials, is primarily destined to hospitals, where it will help monitor vitals of premature babies and children up to 12 years old.

The company, quickly realizing the potential of this technology, recently extended their product range to target adults and elderly, aiding especially in the caregiving industry where it could help monitor senile conditions. Thanks to the strong know-how developed since 2010, when the company was born, the smart textile technology could be easily declined to other applications in the very profitable fitness industry, including Formula 1, professional football and extreme sports.

ComfTech was helped by external funding, receiving 7 million € in financing from Principia SGR, an Italian company specialized in venture and growth capitalism (EconomyUp, 2018). This investment is proof of the market belief in the success of wearable technologies.

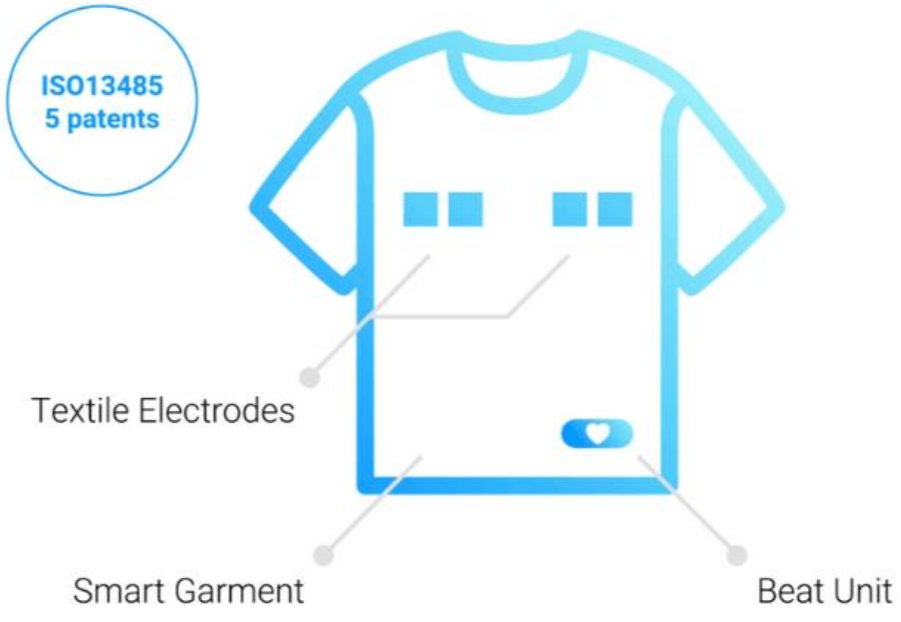

Figure 4 - Simple illustration of the components in ComfTech's products, source: comftech.com

3.3 Empatica

Empatica, also operating in the medical industry like ComfTech, is a start-up from Milan now collaborating with the Massachusetts Institute of Technology. Their most innovative device is the Embrace 2, a smartwatch able to monitor stress, excitement, emotional states and sleep. It's most unique feature, however, is the detection, from perspiration, of the electrical conduction capacity of the skin. Thanks to this information, provided in real-time, the Embrace can understand when the person wearing it is having a seizure, promptly alerting caregivers or emergency services from the smartphone connected to it.

Because of its potentially life-saving purpose, the device had to be designed in such a way as to ensure continuous use, therefore the Empatica team made sure to develop a water-resistant smartwatch that could easily withstand showers, and included a long-lasting (considering its small size) and fast-charging battery, so that users would have to stay without it only for 30 minutes every 48 hours in order to charge it.

The Embrace, which was launched in 2016 through a crowdfunding campaign, is the very first smartwatch to be approved by the FDA – the entity regulating food and drugs in the USA – as a medical device in the neurological field. (Redazione Millionaire, 2018)

Figure 5 - Rendering of the Embrace 2, source: empatica.com

3.4 Wearable Italia

Wearable Italia is an Italian start-up company founded in February 2016 by IT engineer, and now CEO, Andrea Tomassini with the aim of combining Made in Italy design appreciated globally and innovative wearable technologies.

In order to ensure its success, the company deposited several industrial patents in collaboration with best-in-class manufacturers of hardware, software, home automation and Internet of Things. In July 2018 Wearable Italia published on Kickstarter – a notorious crowdfunding website – a campaign to fund their smart jewellery collection, managing to reach the funding goal in just 6 days.

The star of their jewellery collection is ProdigIO, a smart and multi-functional bracelet, able to track fitness data like steps taken during the day, distance walked, calories burnt; alert through vibration and delicate LEDs when notifications are received; and – probably the bracelet's most unique feature – trigger an alarm in case the emergency button on the side is pressed, sharing the GPS position of the person wearing the bracelet and sending a live recording through the smartphone's microphone to selected contacts.

Wearable Italia's work proves that designing an innovative and connected product does not exclude paying attention to factors that are fundamental in the pre-IoT product, reason why the company realizes ProdigIO with an attractive design and with precious material such as gold, silver, and ruthenium, highly appreciated features in *standard* jewellery.

Furthermore, the company made sure that the products would be interoperable with many other similar devices, designing their dedicated smartphone app in such a way as to allow the data collected to be also incorporate in other popular fitness apps like Google Fit and Apple Health. Interoperability is a fundamental feature for smart and successful devices, as was previously explained, and it makes users able to alternate between the use of ProdigIO and other smart fitness bands connected to those apps and still have a streamline flow of health and fitness data, even if using different devices to collect it.

Wearable Italia has emphasized the fact that this "is not smart jewellery, but jewellery made smart". This means they have focused primarily on a public looking for beautiful accessories which also happen to have smart features. (Jariwala, 2018) (WearableItalia, 2018)

Figure 6 - Wearable Italia's ProdigIO in model Fluid silver, source: wearableitalia.com

3.5 GlassUp

GlassUp, born as a small start-up in northern Italy, is the creator of F4, an augmented reality visor designed to revolutionize industrial work by providing support to workers during many types of tasks.

The F4 has the external appearance of a futuristic protective mask and thanks to a video camera, many sensors including a gyroscope and a compass, wi-fi and Bluetooth connectivity, and many more features, can allow access to content such as videos, images, instruction manuals and any type of content useful to support the work process, providing operators in the field with valuable information to intervene on plants and machinery in real time and leaving their hands free to operate.

In addition to the software suite that accompanies the glasses, GlassUp is able to offer integration, support and development services to companies interested in the implementation of F4 within their own production processes or technological offers, thanks to the large volume of knowledge intensive capital of the company. This allows GlassUp to provide hyper-customization of the product, tailoring the offer to each client's needs.

Contrarily to Wearable Italia, GlassUp focused on the functionality and utility of their product, disregarding aesthetical features, highly irrelevant to the target audience of this visor. Indeed, a popular field of application for the F4 is the construction industry, where the usage of augmented reality devices is increasing. Currently, the F4 is adopted by more than 50 on-field

teams around Italy and Europe, helping with bar-codes and meter reading, video recording of on-field interventions and remote assistance support.

Other important fields of application for the F4 are manufacturing, where the device's connectivity can aid by providing remote assistance, while the integrated camera and augmented reality can support quality control; and healthcare, which would see a significant increase of efficiency and precision thanks to augmented reality.

The company's success was greatly aided also by the victory of two Horizon 2020 calls - a research and innovation programme founded by the European Union - for a total value of around 1.5 million of euros. GlassUp was also among the 5 Italian finalists for the Innovation Radar Prize 2018, a competition launched by the European Commission to identify the most innovative European companies (GlassUp, 2017). These initiatives can prove crucial in the survival of innovative start-ups, which would otherwise fail rapidly due to lack of funds, causing society to lose the contribution to progress the innovative companies would have made.

Figure 7 - Rendering of GlassUp's F4. Source: glassup.com

3.6 Comparison between the companies

The following table offers a comparison between the main elements which characterize the four companies mentioned. From this analysis, it emerges that different purposes and intended users require different attentions during the development of the product and that all smart devices are paired up with an external software counterpart, whether that is a smartphone application or a computer program.

Table 4 - Comparison between the four companies mentioned

COMPANY	PRODUCT PURPOSE	INTENDED USER	ELEMENTS IN THE ECOSYSTEM	CONCERNS DURING PRODUCT DEVELOPMENT
ComfTech	Keeping track of infants' vitals to help diagnosis and monitor health status.	Infants; possibly athletes/fitness enthusiasts	Smartphone app for data tracking; baby monitors; hospital database.	Possible adverse reactions on sensitive skin; scalability to extend applications to fitness market.
Empatica	Monitoring epilepsy and alerting emergency contacts in case of a seizure.	People suffering from epilepsy	Diary-app to keep records; dedicated app for alerting emergency services and loved ones.	Long-lasting and fast-charging battery; water resistance.
Wearable Italia	Decorative accessory; secondary purpose of monitoring health and alerting emergency contacts in case of need.	Jewellery lovers	Smartphone app for tracking and sending alerts.	Aesthetics; light weight; ease of use; interoperability.
GlassUp	Support in manufacturing, construction, training, quality control, etc. (depends on client needs).	Workers	Remote control dashboards on computer; other elements depend on client needs.	Ease of use, high resistance to dust and shocks, high customization

Conclusions

Today's smart connected products are more innovative and more data-centric, involving more software than any other product ever produced until now. This implies a deep understanding of all implications that come with the rise of the internet of things, in order to succeed and harness the opportunities it has to offer.

IoT based technologies can be applied in almost every field, providing both established firms and new entrants with many unexplored business opportunities. To seize these occasions companies must obtain and develop deep knowledge of the software component, which is an extremely relevant part in the success of connected devices, to grant both ease of use thanks to user-friendly interfaces and compatibility and interoperability between devices.

Heavily relying on software, however, implies also threats regarding security, which must be given great importance in order to protect the information collected by the devices and the privacy of the people using them.

The rising number of devices connected to the internet of things is producing a massive amount of data, which must be properly managed in order to effectively benefit from it. To analyse it, firms must build networks capable of handling it and provide output in a serviceable way. This volume of precious information can grant companies great strategic advantages in terms of knowing consumers' desires and behaviour, in order to predict trends and improve existing products.

The data collected can be extremely useful during the innovation process too, aiding in the phase of idea generation and concept screening. The production of prototypes is helped by this too thanks to simulations like the digital twin, while later stages are supported by the information provided by sensors on batches of products.

Among markets for the internet of things, the one of wearable technologies poses peculiar challenges correlated to the nature of the products, typically smaller and more mobile than those in other fields and requiring a higher degree of attention to aesthetics. Nevertheless, some Italian companies managed to succeed, bringing to the market highly innovative products appreciated by final users.

Word count: 9914/10000

References

Bellini, M. (2018, settembre 3). *Tag etichetta RFID: cos'è, come funziona ed esempi dell'identificazione a radiofrequenze.* Retrieved aprile 18, 2019, from Internet 4 things.

Bellini, M. (2019, febbraio 9). *IoT (Internet of Things): significato, esempi e applicazioni pratiche*. Retrieved aprile 13, 2019, from Internet 4 Things.

Brandon-Jones, A., Slack, N., & Johnston, R. (2016). *Operations Management.* s.l.: Pearson Education Limited.

Caprodossi, A. (2017, gennaio 14). *Flop o nicchia di mercato? Il futuro della wearable technology.* Retrieved maggio 13, 2019, from GQItalia.

Cline, G. (2017). *Product development in the era of IoT: tying the digital thread.* s.l.: Aberdeen Group.

Coscia, E. (2016). Innovazione di prodotto e ruolo delle tecnologie IoT. *"Internet of Things per l'innovazione di prodotto" - Confartigianato Imprese Marca Trevigiana.* Treviso. Retrieved maggio 4, 2019

Di Maria, E., & Bettiol, M. (2014). L'innovazione. In A. Tunisini, T. Pencarelli, & L. Ferrucci, *Economia e Management delle imprese* (pp. 434-460). Milano: Ulrico Hoepli Editore.

EconomyUp. (2018, agosto 6). *Health: 7 milioni a Comftech, startup dei wearable per neonati e sportivi.* Retrieved giugno 2, 2019, from EconomyUp.

Evans, D. (2011). *The Internet of Things - How the next evolution of the internet is changing everything.* s.l.: Cisco Internet Business Solutions Group (IBSG).

Foust, J. (2019). SpaceX's space-Internet woes: Despite technical glitches, the company plans to launch the first of nearly 12,000 satellites in 2019. *IEEE Spectrum*, *56*(1), 50-51.

GlassUp. (2017). *GlassUp - GlassUp F4*. Retrieved maggio 31, 2019, from https://www.glassup.com/en/f4/

Greengard, S. (2017). *Internet delle cose.* Bologna: Società editrice il Mulino.

Gruosso, G. (2017, ottobre 17). *Cos'è l'IoT per l'innovazione di prodotto*. Retrieved maggio 12, 2019, from Ricomincio da 4.

Gupta, A. (2019). *The IoT Hacker's Handbook: A Practical Guide to Hacking the Internet of Things.* Walnut, CA, USA: Apress. doi:10.1007/978-1-4842-4300-8

HT, R. (2018, maggio 27). *Internet of things: Smart Products e servizi innovativi per la creazione di nuovi modelli di business*. Retrieved from H-T Tecnology.

Institute, M. G. (2015). *Internet of Things: Mapping the Value Beyond the Hype - Executive Summary.* s.l.: McKinsey&Company.

Internationa Data Corporation. (2019, marzo 5). *IDC Reports Strong Growth in the Worldwide Wearables Market, Led by Holiday Shipments of Smartwatches, Wrist Bands, and Ear-Worn Devices.* Retrieved giugno 4, 2019, from IDC - Analyse the future.

Jariwala, A. (2018, luglio 5). ProdigIO Smart Bracelet Launched at an Early Bird Price of $199. *The Wearable News*.

Johnson, G., Whittington, R., & Scholes, K. (2014). *Strategia Aziendale.* (A. Pace, Ed.) s.l.: Pearson.

Loka, S. (2017, marzo 30). *Impact of IoT on Product Innovation.* Retrieved aprile 21, 2019, from coMakeIT.

Mamtani, K. (2017, aprile). Wearable Technology Market - Global Opportunity Analysis and Industry Forecast, 2014-202. *REPORT CODE: CO 17355*. Allied Market Research.

Porter, M., & Heppelmann, J. (2015, ottobre). How Smart, Connected Products Are Transforming Companies. *Harvard Business Review*(114), pp. 96-112.

Rayes, A., & Salam, S. (2018). *Internet of Things From Hype to Reality - The Road to Digitization.* San Jose, CA, USA: Springer. doi:10.1007/978-3-319-99516-8

Redazione Millionaire. (2018, febbraio 8). *Embrace, lo smartwatch italiano antiepilessia approvato negli Stati Uniti*. Retrieved maggio 28, 2019, from Millionare.

Roche, S., Nabian, N., Kloeckl, K., & Ratti, C. (2012). *Are 'Smart Cities' Smart Enough?*

Scarano, A. (2016, novembre 4). *Ho provato Apple Watch Nike+, l'orologio che ti fa correre.* Retrieved maggio 3, 2019, from GQItalia: https://www.gqitalia.it/gadget/hi-tech/2016/11/04/ho-provato-lapple-watch-nike-lorologio-che-ti-motiva-a-correre

Skarmeta, A., Hernández-Ramos, J., & Martinez, J. (2019). User-Centric Privacy. In S. Ziegler, *Internet of Things Security and Data Protection* (pp. 185-203). s.l.: Springer International Publishing. doi:10.1007/978-3-030-04984-3

Velivela, V. (2015, settembre). Small Satellite Constellations: The Promise of 'Internet for All'. *ORF ISSUE BRIEF*(107).

WearableItalia. (2018). *Wearable Italia – Join the revolution of wearable technologies*. Retrieved maggio 27, 2019, from https://www.wearableitalia.com/